Laboratory for Advanced Software Systems
University of Luxembourg

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- lu.uni.lassy.messir.libraries.calendar.dtDateAndTime.isNow
- lu.uni.lassy.messir.libraries.calendar.dtDateAndTime.lt
- lu.uni.lassy.messir.libraries.calendar.dtDateAndTime.toSecondsQty
- lu.uni.lassy.messir.libraries.calendar.dtDay.close
- lu.uni.lassy.messir.libraries.calendar.dtDay.is
- lu.uni.lassy.messir.libraries.calendar.dtHour.close
- lu.uni.lassy.messir.libraries.calendar.dtHour.is
- lu.uni.lassy.messir.libraries.math.dtInteger.acos
- lu.uni.lassy.messir.libraries.math.dtInteger.add
- lu.uni.lassy.messir.libraries.math.dtInteger.asdtReal
- lu.uni.lassy.messir.libraries.math.dtInteger.asin
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- lu.uni.lassy.messir.libraries.math.dtInteger.atan
- lu.uni.lassy.messir.libraries.math.dtInteger.close
- lu.uni.lassy.messir.libraries.math.dtInteger.cos
- lu.uni.lassy.messir.libraries.math.dtInteger.eq

- lu.uni.lassy.messir.libraries.math.dtInteger.frac
- lu.uni.lassy.messir.libraries.math.dtInteger.geq
- lu.uni.lassy.messir.libraries.math.dtInteger.gt
- lu.uni.lassy.messir.libraries.math.dtInteger.is
- lu.uni.lassy.messir.libraries.math.dtInteger.leq
- lu.uni.lassy.messir.libraries.math.dtInteger.lt
- lu.uni.lassy.messir.libraries.math.dtInteger.mod
- lu.uni.lassy.messir.libraries.math.dtInteger.msrabs
- lu.uni.lassy.messir.libraries.math.dtInteger.msrdiv
- lu.uni.lassy.messir.libraries.math.dtInteger.mul
- lu.uni.lassy.messir.libraries.math.dtInteger.neq
- lu.uni.lassy.messir.libraries.math.dtInteger.opp
- lu.uni.lassy.messir.libraries.math.dtInteger.power
- lu.uni.lassy.messir.libraries.math.dtInteger.sin
- lu.uni.lassy.messir.libraries.math.dtInteger.sqr
- lu.uni.lassy.messir.libraries.math.dtInteger.sqrt
- lu.uni.lassy.messir.libraries.math.dtInteger.sub
- lu.uni.lassy.messir.libraries.math.dtInteger.tan
- lu.uni.lassy.messir.libraries.math.dtInteger.toDeg
- lu.uni.lassy.messir.libraries.math.dtInteger.toRad
- lu.uni.lassy.messir.libraries.math.dtInteger.todtString
- lu.uni.lassy.messir.libraries.calendar.dtMinute.close
- lu.uni.lassy.messir.libraries.calendar.dtMinute.is
- lu.uni.lassy.messir.libraries.calendar.dtMonth.close
- lu.uni.lassy.messir.libraries.calendar.dtMonth.is
- lu.uni.lassy.messir.libraries.math.dtReal.acos
- lu.uni.lassy.messir.libraries.math.dtReal.add
- lu.uni.lassy.messir.libraries.math.dtReal.asdtInteger
- lu.uni.lassy.messir.libraries.math.dtReal.asin
- lu.uni.lassy.messir.libraries.math.dtReal.asptReal

- lu.uni.lassy.messir.libraries.math.dtReal.atan
- lu.uni.lassy.messir.libraries.math.dtReal.close
- lu.uni.lassy.messir.libraries.math.dtReal.cos
- lu.uni.lassy.messir.libraries.math.dtReal.eq
- lu.uni.lassy.messir.libraries.math.dtReal.frac
- lu.uni.lassy.messir.libraries.math.dtReal.geq
- lu.uni.lassy.messir.libraries.math.dtReal.gt
- lu.uni.lassy.messir.libraries.math.dtReal.is
- lu.uni.lassy.messir.libraries.math.dtReal.leq
- lu.uni.lassy.messir.libraries.math.dtReal.lt
- lu.uni.lassy.messir.libraries.math.dtReal.msrabs
- lu.uni.lassy.messir.libraries.math.dtReal.msrdiv
- lu.uni.lassy.messir.libraries.math.dtReal.msrround
- lu.uni.lassy.messir.libraries.math.dtReal.mul
- lu.uni.lassy.messir.libraries.math.dtReal.neq
- lu.uni.lassy.messir.libraries.math.dtReal.opp
- lu.uni.lassy.messir.libraries.math.dtReal.power
- lu.uni.lassy.messir.libraries.math.dtReal.sin
- lu.uni.lassy.messir.libraries.math.dtReal.sqr
- lu.uni.lassy.messir.libraries.math.dtReal.sqrt
- lu.uni.lassy.messir.libraries.math.dtReal.sub
- lu.uni.lassy.messir.libraries.math.dtReal.tan
- lu.uni.lassy.messir.libraries.math.dtReal.toDeg
- lu.uni.lassy.messir.libraries.math.dtReal.toRad
- lu.uni.lassy.messir.libraries.math.dtReal.todtString
- lu.uni.lassy.messir.libraries.calendar.dtSecond.close
- lu.uni.lassy.messir.libraries.calendar.dtSecond.is
- lu.uni.lassy.messir.libraries.string.dtString.close
- lu.uni.lassy.messir.libraries.string.dtString.dtStringConcat
- lu.uni.lassy.messir.libraries.string.dtString.eq

- lu.uni.lassy.messir.libraries.string.dtString.geq
- lu.uni.lassy.messir.libraries.string.dtString.gt
- lu.uni.lassy.messir.libraries.string.dtString.is
- lu.uni.lassy.messir.libraries.string.dtString.length
- lu.uni.lassy.messir.libraries.string.dtString.leq
- lu.uni.lassy.messir.libraries.string.dtString.lt
- lu.uni.lassy.messir.libraries.string.dtString.neq
- lu.uni.lassy.messir.libraries.string.dtString.subdtString
- lu.uni.lassy.messir.libraries.string.dtString.toLower
- lu.uni.lassy.messir.libraries.string.dtString.toUpper
- lu.uni.lassy.messir.libraries.string.dtString.toptString
- lu.uni.lassy.messir.libraries.calendar.dtTime.close
- lu.uni.lassy.messir.libraries.calendar.dtTime.eq
- lu.uni.lassy.messir.libraries.calendar.dtTime.fromSecondsQty
- lu.uni.lassy.messir.libraries.calendar.dtTime.gt
- lu.uni.lassy.messir.libraries.calendar.dtTime.is
- lu.uni.lassy.messir.libraries.calendar.dtTime.isNow
- lu.uni.lassy.messir.libraries.calendar.dtTime.lt
- lu.uni.lassy.messir.libraries.calendar.dtTime.toSecondsQty
- lu.uni.lassy.messir.libraries.calendar.dtYear.close
- lu.uni.lassy.messir.libraries.calendar.dtYear.is
- lu.uni.lassy.messir.libraries.primitives.ptBoolean.close
- lu.uni.lassy.messir.libraries.primitives.ptBoolean.eq
- lu.uni.lassy.messir.libraries.primitives.ptBoolean.is
- lu.uni.lassy.messir.libraries.primitives.ptBoolean.msrand
- lu.uni.lassy.messir.libraries.primitives.ptBoolean.msrnot
- lu.uni.lassy.messir.libraries.primitives.ptBoolean.msror
- lu.uni.lassy.messir.libraries.primitives.ptBoolean.msrxor
- lu.uni.lassy.messir.libraries.primitives.ptBoolean.neq
- lu.uni.lassy.messir.libraries.primitives.ptInteger.acos

- lu.uni.lassy.messir.libraries.primitives.ptInteger.add
- lu.uni.lassy.messir.libraries.primitives.ptInteger.asin
- lu.uni.lassy.messir.libraries.primitives.ptInteger.asptReal
- lu.uni.lassy.messir.libraries.primitives.ptInteger.atan
- lu.uni.lassy.messir.libraries.primitives.ptInteger.close
- lu.uni.lassy.messir.libraries.primitives.ptInteger.cos
- lu.uni.lassy.messir.libraries.primitives.ptInteger.eq
- lu.uni.lassy.messir.libraries.primitives.ptInteger.frac
- lu.uni.lassy.messir.libraries.primitives.ptInteger.geq
- lu.uni.lassy.messir.libraries.primitives.ptInteger.gt
- lu.uni.lassy.messir.libraries.primitives.ptInteger.is
- lu.uni.lassy.messir.libraries.primitives.ptInteger.leq
- lu.uni.lassy.messir.libraries.primitives.ptInteger.lt
- lu.uni.lassy.messir.libraries.primitives.ptInteger.mod
- lu.uni.lassy.messir.libraries.primitives.ptInteger.msrabs
- lu.uni.lassy.messir.libraries.primitives.ptInteger.msrdiv
- lu.uni.lassy.messir.libraries.primitives.ptInteger.mul
- lu.uni.lassy.messir.libraries.primitives.ptInteger.neq
- lu.uni.lassy.messir.libraries.primitives.ptInteger.opp
- lu.uni.lassy.messir.libraries.primitives.ptInteger.power
- lu.uni.lassy.messir.libraries.primitives.ptInteger.sin
- lu.uni.lassy.messir.libraries.primitives.ptInteger.sqr
- lu.uni.lassy.messir.libraries.primitives.ptInteger.sqrt
- lu.uni.lassy.messir.libraries.primitives.ptInteger.sub
- lu.uni.lassy.messir.libraries.primitives.ptInteger.tan
- lu.uni.lassy.messir.libraries.primitives.ptInteger.toDeg
- lu.uni.lassy.messir.libraries.primitives.ptInteger.toRad
- lu.uni.lassy.messir.libraries.primitives.ptInteger.toptString
- lu.uni.lassy.messir.libraries.primitives.ptReal.acos
- lu.uni.lassy.messir.libraries.primitives.ptReal.add

- lu.uni.lassy.messir.libraries.primitives.ptReal.asin
- lu.uni.lassy.messir.libraries.primitives.ptReal.asptInteger
- lu.uni.lassy.messir.libraries.primitives.ptReal.atan
- lu.uni.lassy.messir.libraries.primitives.ptReal.close
- lu.uni.lassy.messir.libraries.primitives.ptReal.cos
- lu.uni.lassy.messir.libraries.primitives.ptReal.eq
- lu.uni.lassy.messir.libraries.primitives.ptReal.frac
- lu.uni.lassy.messir.libraries.primitives.ptReal.geq
- lu.uni.lassy.messir.libraries.primitives.ptReal.gt
- lu.uni.lassy.messir.libraries.primitives.ptReal.is
- lu.uni.lassy.messir.libraries.primitives.ptReal.leq
- lu.uni.lassy.messir.libraries.primitives.ptReal.lt
- lu.uni.lassy.messir.libraries.primitives.ptReal.msrabs
- lu.uni.lassy.messir.libraries.primitives.ptReal.msrdiv
- lu.uni.lassy.messir.libraries.primitives.ptReal.msrround
- lu.uni.lassy.messir.libraries.primitives.ptReal.mul
- lu.uni.lassy.messir.libraries.primitives.ptReal.neq
- lu.uni.lassy.messir.libraries.primitives.ptReal.opp
- lu.uni.lassy.messir.libraries.primitives.ptReal.power
- lu.uni.lassy.messir.libraries.primitives.ptReal.sin
- lu.uni.lassy.messir.libraries.primitives.ptReal.sqr
- lu.uni.lassy.messir.libraries.primitives.ptReal.sqrt
- lu.uni.lassy.messir.libraries.primitives.ptReal.sub
- lu.uni.lassy.messir.libraries.primitives.ptReal.tan
- lu.uni.lassy.messir.libraries.primitives.ptReal.toDeg
- lu.uni.lassy.messir.libraries.primitives.ptReal.toRad
- lu.uni.lassy.messir.libraries.primitives.ptReal.toptString
- lu.uni.lassy.messir.libraries.primitives.ptString.close
- lu.uni.lassy.messir.libraries.primitives.ptString.eq
- lu.uni.lassy.messir.libraries.primitives.ptString.geq

- lu.uni.lassy.messir.libraries.primitives.ptString.gt
- lu.uni.lassy.messir.libraries.primitives.ptString.is
- lu.uni.lassy.messir.libraries.primitives.ptString.length
- lu.uni.lassy.messir.libraries.primitives.ptString.leq
- lu.uni.lassy.messir.libraries.primitives.ptString.lt
- lu.uni.lassy.messir.libraries.primitives.ptString.neq
- lu.uni.lassy.messir.libraries.primitives.ptString.ptStringConcat
- lu.uni.lassy.messir.libraries.primitives.ptString.subptString
- lu.uni.lassy.messir.libraries.primitives.ptString.toLower
- lu.uni.lassy.messir.libraries.primitives.ptString.toUpper

Appendix B

Messir Specification Files Listing

B.1 File ./src-gen/messir-spec/.views.msr

```
//
//DON'T TOUCH THIS FILE !!!
//
package uuid7d4b15133efc45b9b0f503fbb2d93068 {
 Concept Model {}
}
```

Listing B.1: Messir Spec. file .views.msr.

B.2 File ./src-gen/messir-spec/library/calendar.msr

```
/*
* Copyright University of Luxembourg
*
* This file is part of EXCALIBUR.
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* it under the terms of the GNU General Public License as published by
* the Free Software Foundation, version 3 of the License.
*
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*
* You should have received a copy of the GNU General Public License
* along with EXCALIBUR in the COPYING.txt file.
* If not, see <http://www.gnu.org/licenses/>.
*
* Last Modification:
*
* @author nicolas.guelfi
* @date Mon May 06 18:10:54 CEST 2013
*/

package lu.uni.lassy.messir.libraries.calendar{

import lu.uni.lassy.messir.libraries.primitives
import lu.uni.lassy.messir.libraries.math

 Concept Model {

  Primary Types {

   datatype dtHour extends dtInteger {
    operation is():ptBoolean
    external operation close() : ptBoolean
   }
```

```
37  datatype dtMinute extends dtInteger {
38   operation is():ptBoolean
39   external operation close() : ptBoolean
40  }
41  datatype dtSecond extends dtInteger {
42   operation is():ptBoolean
43   external operation close() : ptBoolean
44  }
45
46  datatype dtTime {
47   attribute hour:dtHour
48   attribute minute: dtMinute
49   attribute second: dtSecond
50
51   operation is():ptBoolean
52   external operation close() : ptBoolean
53
54   // Logical Operations
55   operation lt(AdtTime:dtTime):ptBoolean
56   operation gt(AdtTime:dtTime):ptBoolean
57   operation eq(AdtTime:dtTime):ptBoolean
58   external operation isNow():ptBoolean
59
60   // Conversion Operations
61   operation toSecondsQty():dtInteger
62   operation fromSecondsQty(AdtInteger:dtInteger):ptBoolean
63  }
64
65  datatype dtYear extends dtInteger {
66   operation is():ptBoolean
67   external operation close() : ptBoolean
68  }
69  datatype dtMonth extends dtInteger {
70   operation is():ptBoolean
71   external operation close() : ptBoolean
72  }
73  datatype dtDay extends dtInteger {
74   operation is():ptBoolean
75   external operation close() : ptBoolean
76  }
77
78  datatype dtDate {
79   attribute year:dtYear
80   attribute month: dtMonth
81   attribute day: dtDay
82
83   operation is():ptBoolean
84   external operation close() : ptBoolean
85
86   // Logical Operations
87   operation lt(AdtDate:dtDate):ptBoolean
88   operation gt(AdtDate:dtDate):ptBoolean
89   operation eq(AdtDate:dtDate):ptBoolean
90   external operation isNow():ptBoolean
91
92   // Conversion Operations
93   operation toSecondsQty():dtInteger
94   operation fromSecondsQty(AdtInteger:dtInteger):ptBoolean
95
96  }
97  datatype dtDateAndTime {
98   attribute date:dtDate
99   attribute time: dtTime
100
101  operation is():ptBoolean
102  external operation close() : ptBoolean
103
104  operation lt(AdtDateAndTime:dtDateAndTime):ptBoolean
105  operation gt(AdtDateAndTime:dtDateAndTime):ptBoolean
106  operation eq(AdtDateAndTime:dtDateAndTime):ptBoolean
```

```
107     external operation isNow():ptBoolean
108
109     // Conversion Operations
110     operation toSecondsQty():dtInteger
111     operation fromSecondsQty(AdtInteger:dtInteger):ptBoolean
112    }
113   }
114  }
115 }
```

Listing B.2: Messir Spec. file calendar.msr.

B.3 File ./src-gen/messir-spec/library/math.msr

```
1 /*
2 * Copyright University of Luxembourg
3 *
4 * This file is part of EXCALIBUR.
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7 * the Free Software Foundation, version 3 of the License.
8 *
9 * EXCALIBUR is distributed in the hope that it will be useful,
10 * but WITHOUT ANY WARRANTY; without even the implied warranty of
11 * MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the
12 * GNU General Public License for more details.
13 *
14 * You should have received a copy of the GNU General Public License
15 * along with EXCALIBUR in the COPYING.txt file.
16 * If not, see <http://www.gnu.org/licenses/>.
17 *
18 * Last Modification:
19 *
20 * @author nicolas.guelfi
21 * @date Mon May 06 18:10:54 CEST 2013
22 */
23
24 package lu.uni.lassy.messir.libraries.math{
25
26 import lu.uni.lassy.messir.libraries.primitives
27 import lu.uni.lassy.messir.libraries.string
28
29  Concept Model {
30
31   Primary Types {
32
33    datatype dtInteger{
34     attribute value:ptInteger
35     // Type checking Operation
36     operation is():ptBoolean
37     external operation close() : ptBoolean
38
39     // Arithmetic Operations
40     operation add(AdtInteger:dtInteger): dtInteger
41     operation sub(AdtInteger:dtInteger): dtInteger
42     operation mul(AdtInteger:dtInteger): dtInteger
43     operation frac(AdtInteger:dtInteger): dtReal
44     operation msrdiv(AdtInteger:dtInteger): dtInteger
45     operation power(AExp:dtInteger): dtInteger
46     operation mod(AdtInteger:dtInteger): dtInteger
47
48     operation sqrt(): dtReal
49     operation msrabs(): dtInteger
50     operation opp(): dtInteger
51     operation sqr(): dtInteger
52
53     // Logical Operations
54     operation eq(AdtInteger:dtInteger): ptBoolean
55     operation neq(AdtInteger:dtInteger): ptBoolean
```

```
56     operation geq(AdtInteger:dtInteger): ptBoolean
57     operation leq(AdtInteger:dtInteger): ptBoolean
58     operation lt(AdtInteger:dtInteger): ptBoolean
59     operation gt(AdtInteger:dtInteger): ptBoolean
60
61     // Trigonometric Operations
62     // default is radian
63     operation cos(): dtReal
64     operation acos(): dtReal
65     operation tan(): dtReal
66     operation atan(): dtReal
67     operation sin(): dtReal
68     operation asin(): dtReal
69     operation toDeg(): dtReal
70     operation toRad(): dtReal
71
72     // Conversion Operations
73     operation asdtReal():dtReal
74     operation todtString():dtString
75     operation asptInteger():ptInteger
76     }
77
78    datatype dtReal {
79     attribute value:ptReal
80
81     // Type checking Operation
82     operation is():ptBoolean
83     external operation close() : ptBoolean
84
85     // Arithmetic Operations
86     operation add(AdtReal:dtReal): dtReal
87     operation sub(AdtReal:dtReal): dtReal
88     operation mul(AdtReal:dtReal): dtReal
89     operation frac(AdtReal:dtReal) : dtReal
90     operation msrdiv(AdtReal:dtReal): dtInteger
91     operation power(AdtReal:dtReal): dtReal
92
93     operation msrround() : dtInteger
94     operation sqrt(): dtReal
95     operation msrabs(): dtReal
96     operation opp(): dtReal
97     operation sqr(): dtReal
98
99     // Logical Operations
100    operation eq(AdtReal:dtReal): ptBoolean
101    operation neq(AdtReal:dtReal): ptBoolean
102    operation geq(AdtReal:dtReal): ptBoolean
103    operation leq(AdtReal:dtReal): ptBoolean
104    operation lt(AdtReal:dtReal): ptBoolean
105    operation gt(AdtReal:dtReal): ptBoolean
106
107    // Trigonometric Operations
108    // default is radian
109    operation cos(): dtReal
110    operation acos(): dtReal
111    operation tan(): dtReal
112    operation atan(): dtReal
113    operation sin(): dtReal
114    operation asin(): dtReal
115    operation toDeg(): dtReal
116    operation toRad(): dtReal
117
118    // Conversion Operations
119    operation asdtInteger():dtInteger
120     operation todtString() : dtString
121    operation asptReal():ptReal
122   }
123  }
124 }
```

```
125 }
```

Listing B.3: Messir Spec. file math.msr.

B.4 File ./src-gen/messir-spec/library/primitives.msr

```
1 /*
2 * Copyright University of Luxembourg
3 *
4 * This file is part of EXCALIBUR.
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13 *
14 * You should have received a copy of the GNU General Public License
15 * along with EXCALIBUR in the COPYING.txt file.
16 * If not, see <http://www.gnu.org/licenses/>.
17 *
18 * Last Modification:
19 *
20 * @author nicolas.guelfi
21 * @date Mon May 06 18:10:54 CEST 2013
22 */
23
24 package lu.uni.lassy.messir.libraries.primitives{
25  Concept Model {
26   Primary Types {
27
28  primitive ptBoolean {
29    external operation is() : ptBoolean
30    external operation close() : ptBoolean
31
32    external operation msrnot() : ptBoolean
33    external operation msror(AptBoolean:ptBoolean) : ptBoolean
34    external operation msrxor(AptBoolean:ptBoolean) : ptBoolean
35    external operation msrand(AptBoolean:ptBoolean) : ptBoolean
36    external operation eq(AptBoolean:ptBoolean) : ptBoolean
37    external operation neq(AptBoolean:ptBoolean) : ptBoolean
38    }
39
40  primitive ptInteger {
41
42    operation is() : ptBoolean
43    external operation close() : ptBoolean
44
45     // Arithmetic Operations
46    external operation add(AptInteger:ptInteger) : ptInteger
47    external operation sub(AptInteger:ptInteger) : ptInteger
48    external operation mul(AptInteger:ptInteger) : ptInteger
49    external operation frac(AptInteger:ptInteger) : ptReal
50    external operation msrdiv(AptInteger:ptInteger) : ptInteger
51    external operation power(AptInteger:ptInteger) : ptInteger
52    external operation mod(AptInteger:ptInteger) : ptInteger
53
54    external operation sqrt() : ptReal
55    external operation msrabs() : ptInteger
56    external operation opp() : ptInteger
57    external operation sqr() : ptInteger
58
59     // Logical Operations
60    external operation eq(AptInteger:ptInteger) : ptBoolean
61    external operation neq(AptInteger:ptInteger) : ptBoolean
62    external operation geq(AptInteger:ptInteger) : ptBoolean
63    external operation leq(AptInteger:ptInteger) : ptBoolean
```

```
64    external operation lt(AptInteger:ptInteger) : ptBoolean
65    external operation gt(AptInteger:ptInteger) : ptBoolean
66
67    // Trigonometric Operations
68    // default is radian
69    external operation cos(): ptReal
70    external operation acos(): ptReal
71    external operation tan(): ptReal
72    external operation atan(): ptReal
73    external operation sin(): ptReal
74    external operation asin(): ptReal
75    external operation toDeg(): ptReal
76    external operation toRad(): ptReal
77
78     // Conversion Operations
79    external operation asptReal() : ptReal
80    external operation toptString() : ptString
81 }
82
83  primitive ptReal {
84
85    operation is() : ptBoolean
86    external operation close() : ptBoolean
87
88    // Arithmetic Operations
89    external operation add(AptReal:ptReal) : ptReal
90    external operation sub(AptReal:ptReal) : ptReal
91    external operation mul(AptReal:ptReal) : ptReal
92    external operation frac(AptReal:ptReal) : ptReal
93    external operation msrdiv(AptReal:ptReal) : ptInteger
94    external operation power(AptReal:ptReal) : ptReal
95
96    external operation msrround() : ptInteger
97    external operation sqrt() : ptReal
98    external operation msrabs() : ptReal
99    external operation opp() : ptReal
100   external operation sqr() : ptReal
101
102    // Logical Operations
103   external operation eq(AptReal:ptReal) : ptBoolean
104   external operation neq(AptReal:ptReal) : ptBoolean
105   external operation geq(AptReal:ptReal) : ptBoolean
106   external operation leq(AptReal:ptReal) : ptBoolean
107   external operation lt(AptReal:ptReal) : ptBoolean
108   external operation gt(AptReal:ptReal) : ptBoolean
109
110    // Trigonometric Operations
111    // default is radian
112   external operation cos(): ptReal
113   external operation acos(): ptReal
114   external operation tan(): ptReal
115   external operation atan(): ptReal
116   external operation sin(): ptReal
117   external operation asin(): ptReal
118   external operation toDeg(): ptReal
119   external operation toRad(): ptReal
120
121    // Conversion Operations
122   external operation asptInteger() : ptInteger
123   external operation toptString() : ptString
124 }
125
126 primitive ptString {
127
128   external operation is() : ptBoolean
129   external operation close() : ptBoolean
130
131   external operation length() : ptInteger
132   external operation ptStringConcat(AptString:ptString) : ptString
133   external operation subptString(
```

```
134             StartIndex:ptInteger,
135             EndIndex:ptInteger
136             ) : ptString
137   external operation toLower():ptString
138   external operation toUpper():ptString
139   external operation eq(AptString:ptString):ptBoolean
140   external operation neq(AptString:ptString):ptBoolean
141   external operation geq(AptString:ptString) : ptBoolean
142   external operation leq(AptString:ptString) : ptBoolean
143   external operation lt(AptString:ptString) : ptBoolean
144   external operation gt(AptString:ptString) : ptBoolean
145   }
146 }
147 }
148 }
```

Listing B.4: Messir Spec. file primitives.msr.

B.5 File ./src-gen/messir-spec/library/string.msr

```
1 /*
2 * Copyright University of Luxembourg
3 *
4 * This file is part of EXCALIBUR.
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6 * it under the terms of the GNU General Public License as published by
7 * the Free Software Foundation, version 3 of the License.
8 *
9 * EXCALIBUR is distributed in the hope that it will be useful,
10 * but WITHOUT ANY WARRANTY; without even the implied warranty of
11 * MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the
12 * GNU General Public License for more details.
13 *
14 * You should have received a copy of the GNU General Public License
15 * along with EXCALIBUR in the COPYING.txt file.
16 * If not, see <http://www.gnu.org/licenses/>.
17 *
18 * Last Modification:
19 *
20 * @author nicolas.guelfi
21 * @date Mon May 06 18:10:54 CEST 2013
22 */
23
24 package lu.uni.lassy.messir.libraries.string{
25
26 import lu.uni.lassy.messir.libraries.primitives
27 import lu.uni.lassy.messir.libraries.math
28
29  Concept Model {
30
31   Primary Types {
32
33    datatype dtString {
34     attribute value:ptString
35
36     // Type checking Operation
37     operation is():ptBoolean
38     external operation close() : ptBoolean
39
40     operation length() : dtInteger
41     operation dtStringConcat(AdtString:dtString) : dtString
42     operation subdtString(StartIndex:dtInteger,
43                 EndIndex:dtInteger
44                  ) : dtString
45
46     operation toLower():dtString
47     operation toUpper():dtString
48
49     operation eq(AdtString:dtString):ptBoolean
```

```
50     operation neq(AdtString:dtString):ptBoolean
51     operation geq(AdtString:dtString) : ptBoolean
52     operation leq(AdtString:dtString) : ptBoolean
53     operation lt(AdtString:dtString) : ptBoolean
54     operation gt(AdtString:dtString) : ptBoolean
55
56     // Conversion Operations
57     operation toptString():ptString
58     }
59   }
60  }
61 }
```

Listing B.5: Messir Spec. file string.msr.